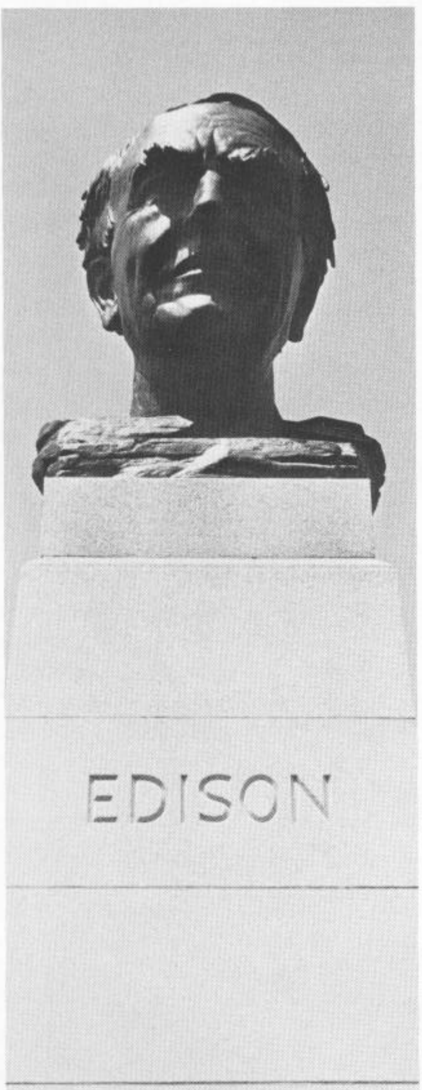
NRL



'a place to sift ideas'

While young Robert Goddard was antagonizing New England neighbors with his noisy contraptions in I915, another visionary gentleman was penning a far-reaching proposal for the *New York Times Magazine*. In July of that year, Thomas A. Edison went on record as saying the Navy should have its own scientific staff to sift the ideas of our inventive nation; that it should have its own laboratory, indigenous to the Naval Establishment, in which the ideas or inventions could be tested and adapted to the special needs of the Navy.

Secretary of the Navy Josephus Daniels wasted no time. American involvement in the War to End All Wars was imminent, and the myriad problems of readying a fleet for the conflict were beginning to inundate the former publisher. He immediately contacted Edison, asking that the Wizard recruit a technical advisory group composed of leading scientists in various fields. They would screen the hundreds of inventions submitted to the Navy, determining which had merit and which were crackpot notions. With typical enthusiasm and energy, Edison rounded up 24 of the biggest names in the scientific-engineering community. These luminaries, operating under the title Naval Consulting Board of the United States, drew up a proposal for a research laboratory to be located either at Annapolis or in southwest Washington, D.C. Edison, on the other hand, had a strong, personal preference for Sandy Hook, at the mouth of New York harbor. Other considerations (one of which was the war itself) had a tendency to bog the committee down, so it was not until 1920 that the elite group was to assemble for the purpose of witnessing the ground breaking for the laboratory.

The formal dedication of the Naval Experimental and Research Laboratory on July 2, 1923, was equally impressive; Franklin D. Roosevelt, Assistant Secretary of the Navy, was the principal speaker. Edison was not present at the ceremony, which took place at the Bellevue Magazine in southwest Washington. As a matter of fact, he never visited the lab. (Some said he might have, had it been located on Sandy Hook.)

Nevertheless, Edison sent a recommendation which was followed to the letter — that the research institution be headed and administered by naval officers, and that the scientific work be placed in the hands of civilians. By the end of the first year, the few scattered radio research groups (and one in water sound study at Annapolis) had been scooped up and deposited at the Washington facility — four officers and 92 civilians. They were off and running. And four decades later, there were four of the original plank-owners still aboard.

The accomplishments of the Naval Research Laboratory (NRL), as it later came to be named, range far and wide. Many of its members were destined for greatness in diverse fields. The NRL list of inventions and achievements is lengthy — too long for this confined perusal of Navy space-related activities. Therefore, most of our observations will be interwoven with other stories throughout this book. One fact, however, warrants our attention at this point: NRL invented radar.

As has already been noted, significant achievements are not easily come by — fun to look back on, perhaps, but at those moments of actual pursuit, elusive goals sometimes existing only in the form of dreams or, possibly more often, nightmares. If one is lucky, he may even have one of those remarkable "accidents" which open up new avenues. But, it still boils down to a *thinking* man's game. Such was the case with radar.

Back in the early Twenties, the terror of the German U-boat was still fresh in people's minds. War from beneath the sea had become an awesome reality. At the same time, radio was just coming into its own. President Harding had broadcast the 1922 dedication of the Lincoln Memorial in Washington, using a transmitter built and installed by an NRL man, L. A. Gebhard. Commerical programs were beginning to make their first impact on the American life. Wireless had made itself indispensable to the fleet as far back as '17 and '18, and now new objectives were established.

Greater range, round-the-clock communication, more channels (with increased stability) — these were goals of NRL, the little group which had become the recognized leader in American radio development. Because the small Navy organization was of modest means, the eager scientists often resorted to a form of bird-dogging. They sniffed over new discoveries and applied them to their own use. Lacking the wherewithal to make components themselves, they often prodded the radio industry into *making* them.

This is not to say that NRL did not do impressive radio research on its own. The NRL-developed, Taylor-Hulbert wave-propogation theory revolutionized prior thinking on how radio waves travel. And the Laboratory designed some very ingenious gadgetry — guidance circuitry for the first successful radio controlled aircraft (1924), and later, for target drones. As for prototype development, many an NRL breadboard (simplified design) model was translated into specifications for standard equipment used throughout the fleet. An example was the radio direction finder and airborne radio for the giant dirigible, *USS Shenandoah*. It was this practice of bird-dogging the new discoveries, combined with in-house research where necessary, that led NRL to radar.

While still at the Anacostia Aircraft Radio Laboratory in 1922, A. H. Taylor and Leo Young noticed the interference caused by a ship passing in the river between their radio transmitter and a receiver on the other side. This was a curious phenomenon, of great interest to the two scientists. Here was a discovery that somehow seemed important.

After the consolidation with NRL, L. A. Gebhard designed the equipment (used by Breit and Tuve of the Carnegie Institution) which measured, by *radio pulses*, the height of the ionosphere. Then, in 1930, NRL scientists observed continuous-wave radio reflections, in the form of "beats," from an aircraft in flight. Now they really had their hands on something. At that point, Taylor determined that intensive research should be undertaken by the Radio Division.

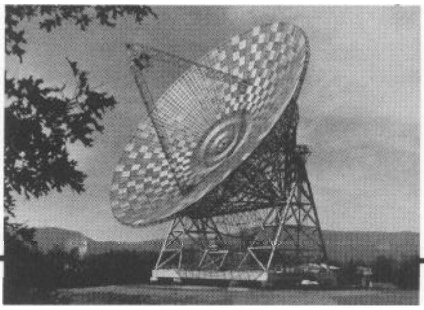
By the following year, complete plans for an *aircraft early warning* system had been worked out on paper. At the time, the system seemed probably more applicable to Army needs, but the Navy work continued. Taylor assigned the task of actually building a pulse system to Leo Young and another promising engineer, Robert M. Page. In 1934, the continuous-wave system was demonstrated to members of Congress. Then Page succeeded in building, for the first time anywhere in the world, a transmitter and receiver that could detect aircraft by radio pulses.

Shipboard installations were constantly improved until, in extensive sea trials during fleet maneuvers in 1939, radar's practicability was proven. Its possibilities were immense, not only for aircraft warning but for navigation and gunfire control. A particularly effective demonstration involved *night* destroyer attacks on major fleet units.

By 1941, nineteen NRL radar models were in use aboard naval ships. That same year, Page developed the plan-position indicator — the familiar radarscope with the round face and the sweeping hand.

All this had been accomplished by a handful of dedicated men in naval research. By soliciting the help and cooperation of the American radio industry, they had come up with a workable system which enabled an operator to "see" in the dark, eventually over great distances. And if any object could be seen — regardless of weather conditions or *through a vacuum* such as space — there were a number of directions toward which the information could be applied. Most important, the invention and development of radar — the system of Radio Detection And Ranging — opened the door for *accurate measurement* and *tracking assessment.*

Without radar, today's space program would be impossible.



NRL'S 150-FOOT STEERABLE ANTENNA

ROCKET POWER

While Americans scratched in the budget barnyard, the German effort moved ahead in giant strides

Robert Collins Truax completed his flight training on June 1, 1943. Designated a Naval Aviator, he received orders to Patrol Squadron 101, then operating out of Perth, Australia. Since the unit was flying PBY's, he considered the assignment an opportunity to test JATO units in an *operating* environment.

But, as an aeronautical engineering officer with *rocket experience* and with "things booming in the JATO business," his orders were suddenly cancelled and he found himself back at the Experiment Station, Annapolis.

In reality, the previous work of the Truax/Goddard team on JATO had met fruition. The Aerojet Engineering Corporation had assumed the reins, and all kinds of JATO units were being prepared for fleet use. Truax shifted his sights to *guided missiles.*

The Germans were ahead of us. So, too, were the Russians, for that matter. We now realize they had test flown a rocket powered interceptor in May 1942 (then they had dropped the project as being relatively *impractical).* It was in 1926, inspired by the works of Goddard and Oberth, that Johannes Winkler started the development of liquid propellant takeoff assistance devices in Dessau, Germany. With hindsight, it is noteworthy that most of the subsequent German work on rocket motors had a strong resemblance to Dr. Goddard's inventions, particularly the innards of the horrendous V-2. While their wartime JATO work more or less fell by the boards (probably for the same reason that the Army Air Corps had lost interest), much activity was generated around the weapons known as guided missiles,

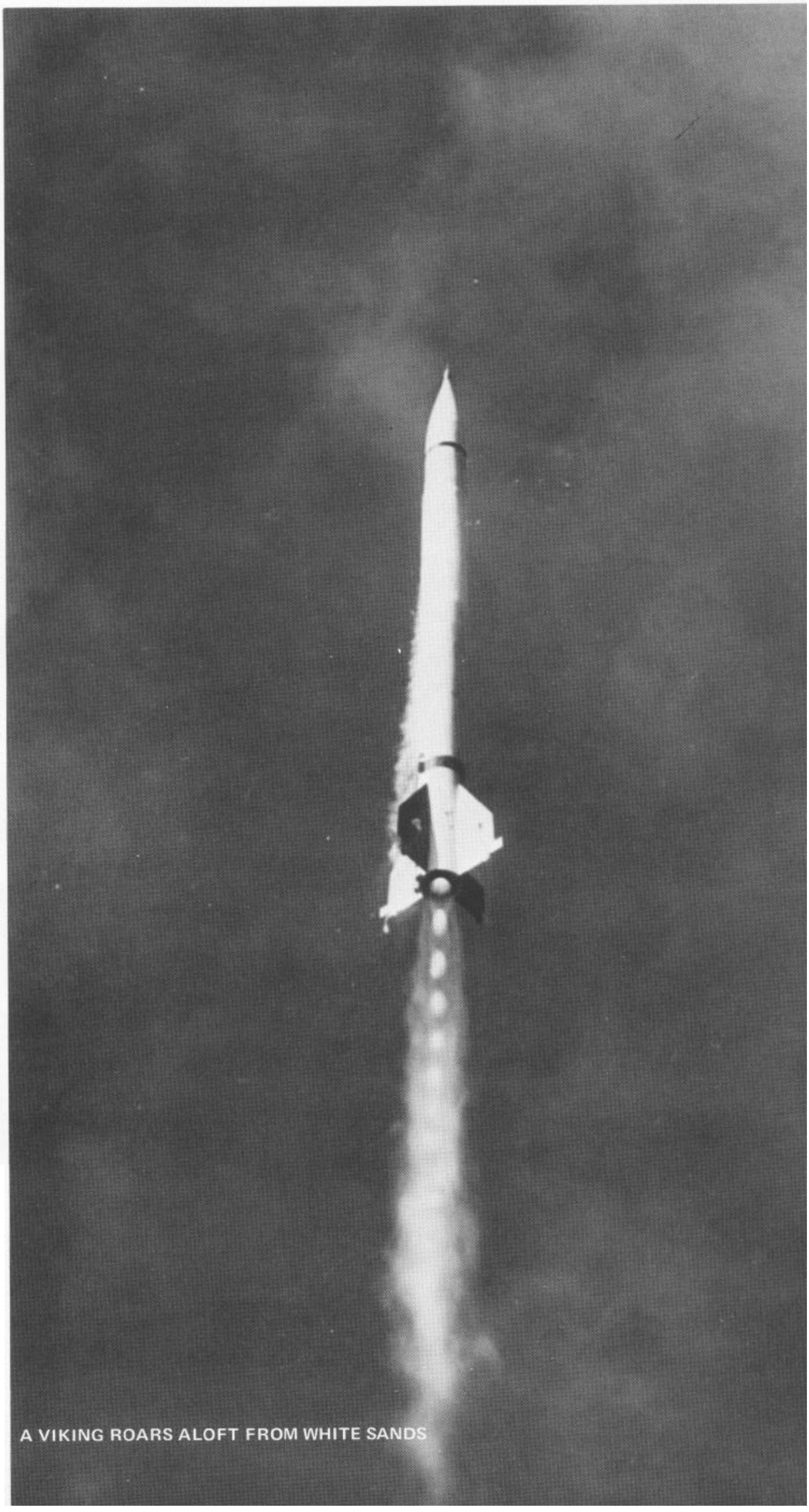
Whereas American interest was, by comparison, limited to a miniscule scratching about in the budget barnyard by a few perceptive visionaries, the German effort was moving ahead in giant strides. Their Army's Peenemuende Center and luftwaffe boss Goering's laboratory at Trauen were lavishly furnished and were undoubtedly the world's most modern rocket research centers. Before the war's end, V-2's were being produced in large numbers, rocket-powered missiles were being used against Allied bombers, and developments in the rocket field promised the Germans an opportunity to actually hit America with exotic weapons.

Though German rocket development was outstanding, it did not meet Hitler's goal. It was a monumental gamble — that failed. The odds were right; the plays were wrong. In some instances, lack of time was a factor. Military expediency led the Germans to accept some untried and not-so-good ideas, in order to "get something into the air" and working against their enemy.

Goering originally established the Trauen facility, giving it almost unlimited powers, simply because the Peenemuende laboratory was a political threat to his air force. He was afraid Dornberger and von Braun might come up with something that would win the war and he, and *his* people, would have had no part in it. He eventually closed down Trauen when "routine" setbacks at Peenemuende led him to believe it was no longer a threat to his Luftwaffe's prestige. Actually, at that time (late 1942), Trauen was ahead of Peenemuende development, and its longer range program was far more promising.

The ME-163B V2 rocket plane, first flown in 1943, was fast, yet it was abandoned because of the danger in its operation; it had a tendency to explode on landing. The *Natter*, half piloted aircraft, half guided missile, had only one operational test. The pilot was killed and the *Natter* was ash-canned.

When the first German radio-controlled bombs (the HS-293 and the Fritz-X) began to hit Allied ships in the Mediterranean, an emergency call went out to the U.S. Navy; NRL responded, on a crash basis. Two destroyers, equipped with signal-analysis gear recorded the German missiles' guidance signals and brought back the data. Within 12 weeks, NRL scientists had built a countermeasure.



A VIKING ROARS ALOFT FROM WHITE SANDS

This equipment not only jammed the German signals but, on several occasions, *took over* control of the weapons and diverted them harmlessly into the sea. Allied bombing of land-based support facilities also helped slow down the German operation, but this, and the jamming technique, only served to stimulate the enemy's counterthinking.

Their analysis of attacks performed in the Mediterranean and Bay of Biscay indicated that more naval ships would have been sunk or damaged had the "mother" aircraft involved been carrying conventional bombs rather than pilotless aircraft. Hence, German emphasis shifted to antiaircraft missiles — guided "flak" — and surface-to-surface weapons.

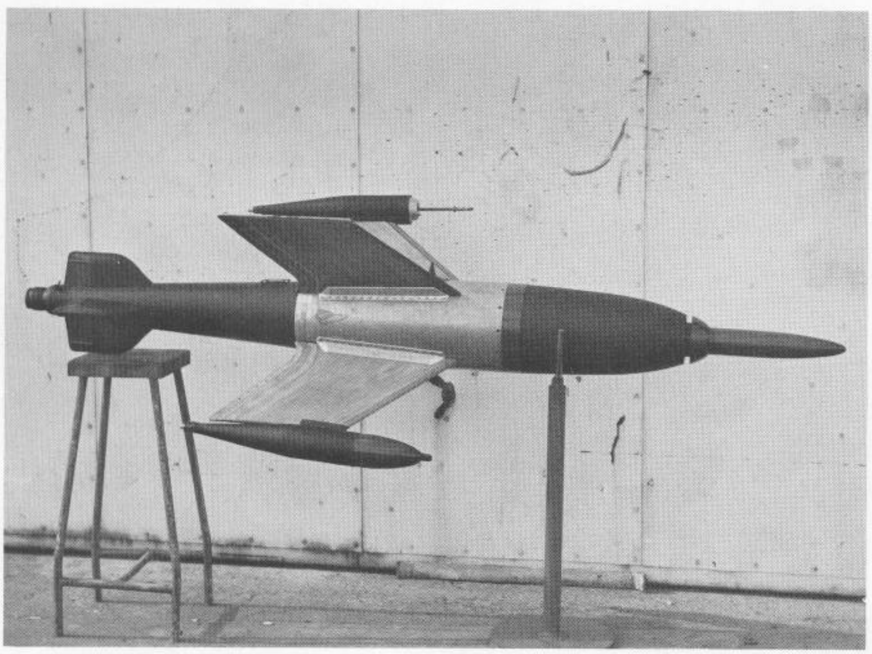
Twelve individual projects were carried through to full development for operational use; the majority were rocket propelled. Of these, the V-2 (A-4), and *Enzian* are probably best known. The A-9/A-10 combination, with a pressurized cockpit for a human pilot, was designed to strike American cities. Fortunately for the U.S., Germany's time ran out.

Back at his Annapolis station, Lt. Truax studied intelligence reports which revealed the advancements in the German missile field. He was also familiar with U.S. Navy efforts to produce an effective air-to-surface missile. *Glombs* and *Glimps* were being developed, and the Bureau of Ordnance (BuOrd) was moving ahead on the *Pelican/Bat* program. But these devices were only *glider* bombs. It was the route the Germans would soon discard.

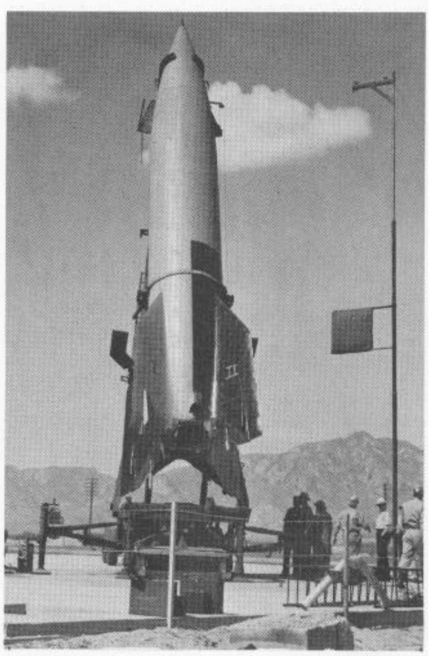
Luckily, in a 1941 memorandum, "Summary and Recommendations for a Jet Propulsion Program" (remember, in those days it was judicious to call a rocket a jet), Truax had urged development of guided missiles. The memo had made the rounds, and, in October 1943, he was asked to build the engine for the *Gorgon,* an ambitious BuAer design for a television guided, pilotless aircraft.

"The *Gorgon* paved the way for expanded Navy activity in the missile business," Truax says. "They had come up with this air-to-air thing powered by two small 9.5-inch jet engines. In effect, they were scale models of what was actually our first turbojet engine. But, small as they were, they cost $11,000 each! The boys in the Bureau said, 'We can't afford *that!'* So they asked me for a *rocket."* Truax grins as he recalls, "We put it together in about 45 days, and it went into production at Reaction Motors. Some 80 or 90 of them were built by early 1944.

"About that time," he continues, "the kamikazes were giving us fits in the Pacific, so everyone began looking around for a *surface-to-air* missile.



German X-4 was a liquid-propelled, rocket-powered, wire-guided missile designed for air-to-air operations. Emphasis on this type of weapon eventually dissipated. In the case of the radio-controlled glide bombs, HS-293 and Fritz-X, an Allied strike destroyed all aircraft modified to carry the missiles. Fuel shortages precluded replacement by the Luftwaffe.



Above, German V-2 is erected for launch at White Sands. Weapon proved possibility of rocket propulsion for space flight. Director of engineering, von Braun, was jailed by Gestapo on sabotage charge: he talked too much about rockets for future space travel — instead of weapons. Hitler released him after being pursuaded the young professor had been carried away by the program.

Now, BuAer and BuOrd sort of competed with each other; BuAer called them pilotless aircraft and BuOrd called them guided missiles. It turned out BuOrd had the best term. Anyway, BuOrd put their money on the Johns Hopkins people who had developed the VT (proximity) fuse, and said, 'Look, we need a surface-to-air missile,' and then BuAer decided to do the same, and they went out to industry and begin to let contracts for the *Lark*. When it came to propulsion, they decided on rockets, Down they came to Annapolis and told us what they needed. So, we took the basic *Gorgon* engine design and came up with a prototype for the twin engine *Lark*. They liked it and turned it over to Reaction Motors for production.

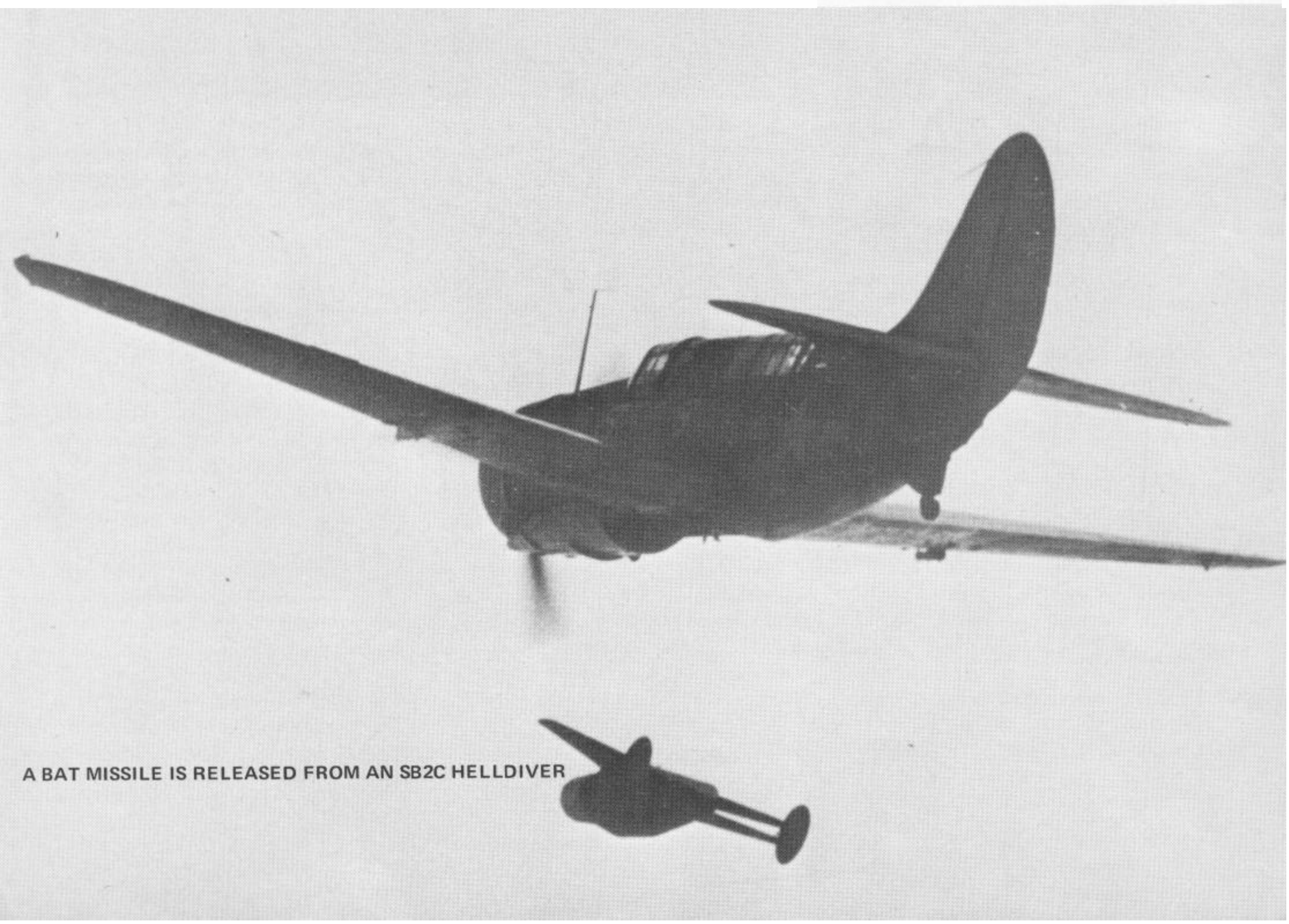
"We did *our* part very quickly, but we paid somewhat for our speed. You see, we had a fellow in our group who was an expert at making thrust chambers. He could take a sketch, without any tolerances or anything else, and just *put the unit together*. Then, when the Navy said to Reaction Motors 'We need 100 of them,' Reaction Motors would say, 'OK, where are the drawings?' And we'd have to say, 'Drawings? Drawings? What drawings?' So, then they'd have to cut the thing apart to see how it was made . . . and try to *duplicate* it!

"Actually, it worked out fine in the long run, though. The *Lark* got its engines. Unfortunately," and here Truax winces a little, "the development time, instead of being 90 days (or some ridiculous figure we were hoping for) — as a counter to the kamikazes — turned out to be considerably more. I think we knocked down the first airplane target after 1950."

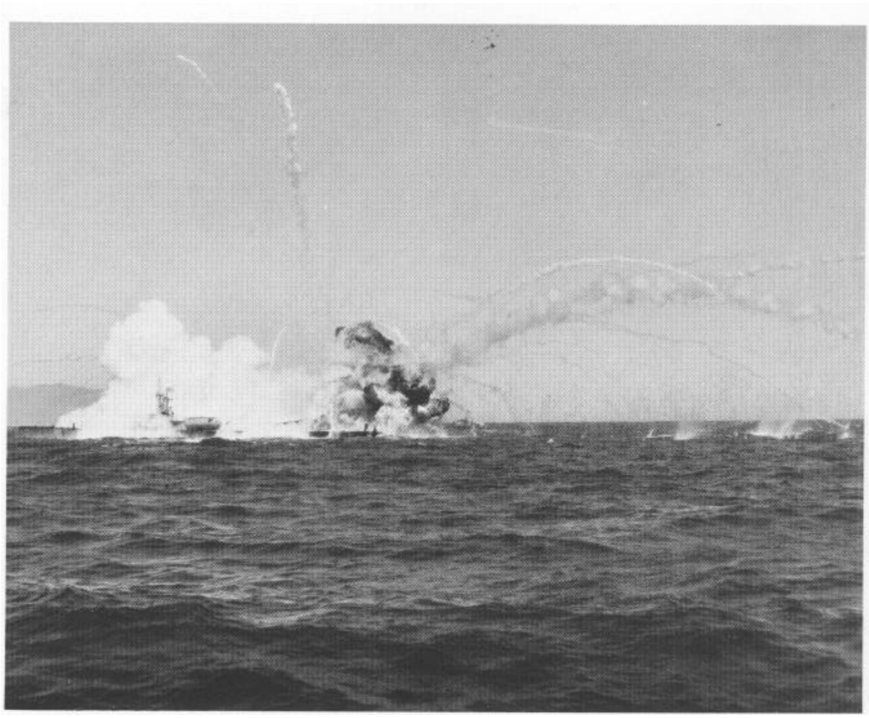
On December 7, 1941, the day of Pearl Harbor, the United States had no rocket weapons. At the time the war ended, the American rocket budget was 13 million. We had found German development included advanced homing devices: infrared, acoustic, electromagnetic (radio) and television. They had an accurate velocity measurement system which made use of the Doppler effect. And telemetering was employed to its full extent.

In the case of the V-2, it is inconceivable that the Germans considered the weapon to be an end in itself, or that, with all its complexities, it was developed (at a cost of billions and manufactured in great quantity with the highest priority) merely to deposit 750 kilograms of explosive on Great Britain. These were men *looking to the stars.*

But that singular man, the one who had been the prime mover — the inspired genius who laid the groundwork for all development in modern rocketry and space flight — did not



A BAT MISSILE IS RELEASED FROM AN SB2C HELLDIVER



live out the war. Dr. Robert Goddard died on August 10, 1945.

His 214 patents covered every basic aspect of rocket design, construction and operation. Goddard had shown the way; his few followers would now be joined by others in the new technology.

Along with the fairly limited wartime indulgence in rocketry, "pilotless aircraft" provided a proving ground for the men with bigger dreams. After Goddard's early experience with the lunatic image, his acolytes took heed. You might not encourage a "trip to the moon," but you could certainly solicit support for seemingly bizarre methods of hitting the enemy — or so it seemed in the 1944-1945 period.

The relatively primitive ASM-2 *Bat* did reasonably well. So did the equivalent German glided, guided bombs (they even sank a battleship with two Fritz-X's). Then there was the Navy's Project *Anvil,* not quite in the context of this story, but interesting as a review of the thinking of the time.

Anvil was the conversion of two Navy PB4Y's to "drones." Not only had we discerned the German effort to develop long-range guided missiles of their own, we had also detected elaborate precautions for insuring a high degree of security.

It was decided to try to hit the exotic German weapons — with an American exotic weapon. The scheme was actually straightforward, and not particularly hazardous. With the Heligoland missile training base as a target, the plan was for a plane, loaded with high explosives and a remote radio-control system, to be taken off and established on level flight long enough for the controlling aircraft to take over. Then the plane's explosive cargo would be armed and the crew would bail out, leaving further journey of the drone to the skill of the controlling plane's pilot. His job was to guide, from a distant, secure position, the television-equipped, lethal bomber down through the anticipated flak, onto its target. The operation was plausible — an opportunity to throw a wrench into the German missile operation, without loss of American life.

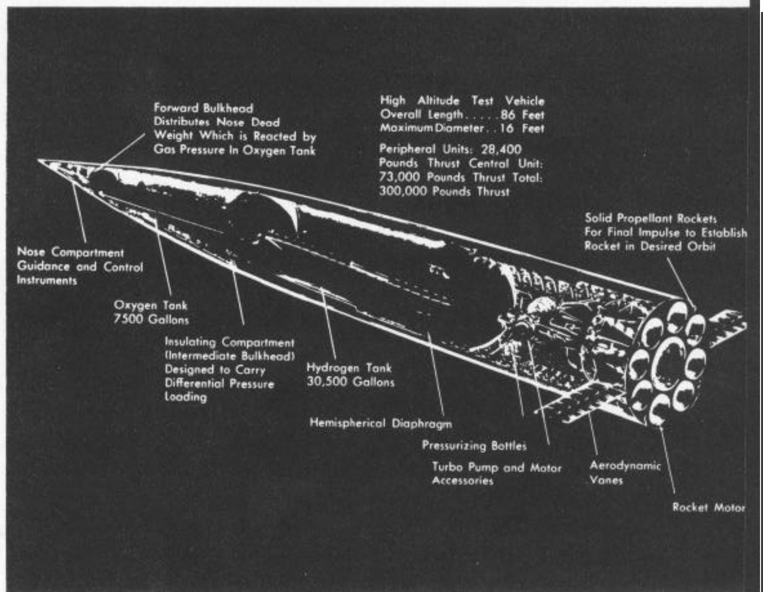
In the fall of 1944, the first PB4Y exploded prematurely while still over England, before reaching its crew-bailout point.* Operation of the second bomber was successful; the Heligoland target was hit on September 3, 1944. No further work was done with the PB4Y (and other) assault drones since the Army was working on a parallel program. But the Navy efforts with pilotless aircraft contributed to the development of guidance components and design criteria for the more sophisticated missiles of the postwar period.

*The pilot was Lt. Joseph Kennedy, the older brother of President John Kennedy.

One result of the Navy's growing experience and expanding interest in rocket propulsion and guidance systems was the report of November 6, 1945, "Feasibility of Space Rocketry," by Commander Harvey Hall and Lieutenant Robert DeHaviland. They were members of a group assigned by BuAer to make a study of future rocket applications. "That report," says Truax, "represents the first United States space program. It proposed that a project be set up for the purpose of constructing and launching an *earth satellite* for scientific purposes."

The satellite project, called HATV (High Altitude Test Vehicle), consisted of a single stage, liquid oxygen/hydrogen rocket capable of achieving an orbit around the earth. The stainless steel craft was to have nine individual motors producing thrust of up to 300,000 pounds at altitude. Inde-

On opposite page, a V-l explodes during 1948 attempt to launch the missile from a submarine, the USS Cusk (SS-348). These experiments paved the way for the Regulus program.



At left, a dummy Viking after launch from USS Norton Sound (AV-11). Above, the 1945 Navy HATV concept, the first U.S. satellite proposal. In 1958, the Navy offered Project Mer, a plan to send a man into orbit in a collapsible pneumatic glider, boosted by a giant launch vehicle.

pendent studies confirmed the vehicle's feasibility. An orbit date in the early Fifties seemed reasonable.

However, cost estimates ran as high as $8,000,000, far more than the Navy would have for such a research endeavor. The BuAer group decided to speak to the Army Air Force about a possible joint effort. At the first meeting, which took place on March 7, 1946, in Washington, the Navy's rocket progress was laid out and the plan for a joint Army Air Force/Navy experimental satellite program was presented. The Army representatives at the meeting were impressed; they agreed to discuss it with their superiors up the line. A few days later, Cdr. Hall was informed that the Army Air Force would not support the Navy satellite program.

Instead, the Army Air Force had asked the West Coast RAND (Research ANd Development) group to come up with a study on the *feasibility of an earth satellite* and, on May 12, RAND presented their report. It was called "Preliminary Design of an Experimental World-Circling Spaceship." In June, another BuAer/AAF meeting was held at which it was pointed out that the AAF (armed with the *brand new* RAND study) was on an equal level with the Navy's position. End of joint project.

The RAND report was a well conceived document. It contained recommendations that were improvements over (and more ambitious than) the Navy's HATV concept. But most remarkable were its two prophetic conclusions: that a satellite with appropriate instrumentation could be one of the most potent scientific tools of the 20th century, and that a United States satellite would inflame the imagination of the world. "To visualize impact," the study stated, "one can imagine the consternation and admiration that would be felt here if the United States were to discover, suddenly, that some other nation had already put up a successful satellite,"

The aeronautical board of the War Department made no decision regarding which service would have jurisdiction of the program, if at all. But the Chief of Naval Operations provided enough money to the BuAer group to keep the project alive. Then LCdr. Truax arrived back on the Washington scene in September 1946.

Since the end of the war, he had been moving about out West. "Once the war was over," Truax says, "people began to complain about the noise at Annapolis, and I was given to understand that my group would have to vacate the Experiment Station. So I picked up my troops, bag and baggage, and went out to California, first to Mohave (the pilotless aircraft unit), and then to Point Mugu where we became the Propulsion Laboratory of the Naval Air Missile Test Center. Shortly after, I was ordered back to the Bureau to head up the rocket desk."

Truax took charge of the development of the engines for Hall's HATV project. But during the following year, a number of events took place which were to have a bearing on the Navy's future role in space. The U.S. Air Force came into being as a separate service in July I947 and, in September the Department of Defense was created, replacing the War Department. The initial Air Force emphasis was placed on strategic bombers and air-breathing missiles rather than satellite programs. This gave Truax and the BuAer group a clear field — for a while. In 1948, because of its lack of military value, funding for HATV was cut off by the Joint Research and Development Board. Harvey Hall went back to civilian life.

To Bob Truax, who had also championed the satellite proposal, the death of HATV was a blow — softened somewhat by the NRL *Viking* program.

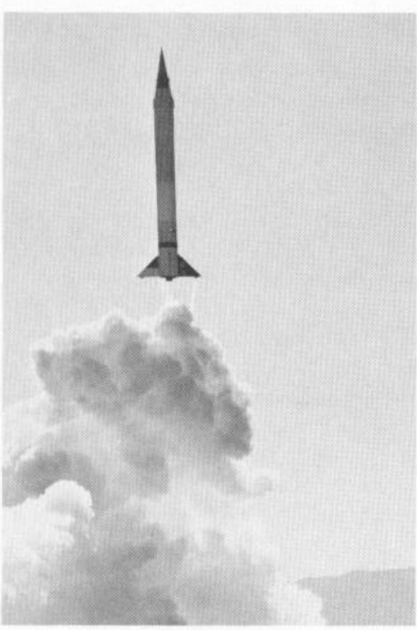
At war's end, NRL had turned its attention to a question which was an outgrowth of the work done by Soucek, Settle and others so many years before: What lies above us in that vast upper area which contains less than one percent of the earth's atmosphere? In 1945, some of the captured German V-2's were put to use as high altitude research vehicles. But, because the ex-weapon was relatively complicated, in limited supply and unsuitable for extended high altitude test programs, it was decided that a completely new, smaller, and more economical *sounding* rocket was needed.

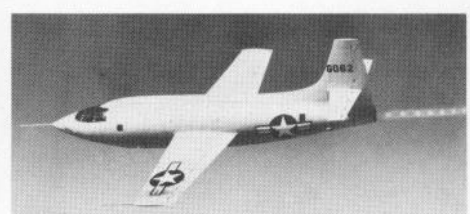
Originally proposed as the *Neptune,* the 45-foot *Viking* emerged. Designed to carry a 500-pound instrument payload, it was used primarily for upper air research. Bob Truax supervised development of its power plants.

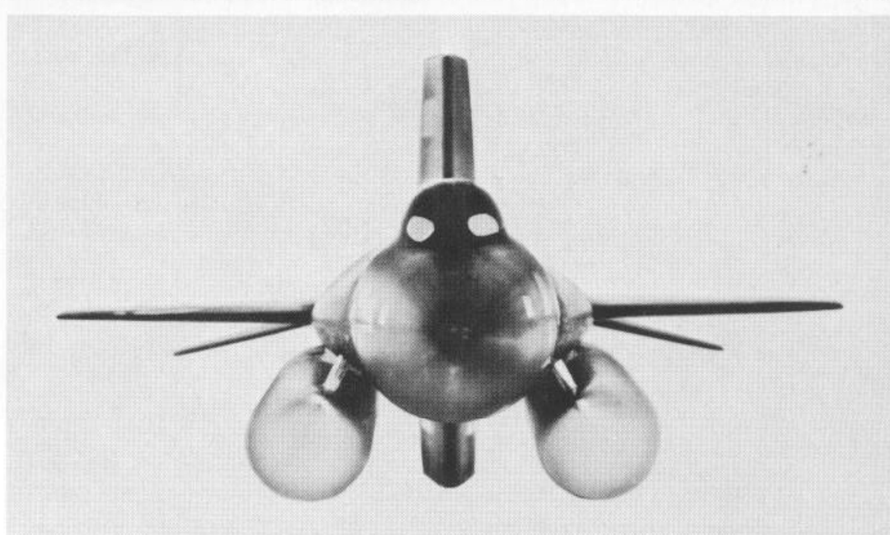
And while he was at it, he "monitored" the power plants which were used in the X-l (the first piloted aircraft to exceed the speed of sound) and the D-558-2 (the first to hit Mach 2) and wrote an interesting proposal for a ballistic missile. "At this time," says Truax, "I completed study for a long-range (1,100 mile) missile for fleet use and succeeded in getting a BuAer endorsement on it. The missile program was rejected by CNO (Chief of Naval Operations) but development of the *engine* for such a missile was initiated and it ended up in the X-15.

"Well, a desk in Washington wasn't really my idea of the best place to build a rocket," Truax admits. "So, I looked around a little bit, and decided that a place up in New Jersey — Lake Denmark — looked promising. Although it was only 35 miles from New York City, the location was in a comparatively wild, hilly region where noisy activity could be conducted without bothering nearby residents.

"And, it was a matter of economics. Test and evaluation take a whale of a lot of money. If a government finances construction of expensive test facilities on a contractor's property, it commits itself to continuing contracts. So, instead, the Navy had a philosophy at that time of doing all testing of contractor-developed engines, both recip-







Above, the successful Viking. Other craft with engines bearing the Truax stamp are depicted at right: the D-558-2, as it drops from a P2B; the Bell X-1, designed for 1,700 miles per hour; and the exotic X-15, shown here with extra propellant tanks.

rocating and gas turbine. I decided we should do the same for rocket engines and I got the facility authorized. Its mission was to furnish high quality test stands and so forth to contractors and other government activities with inadequate facilities of their own. We could also test and evaluate engines and propellants to assure BuAer that contract specifications were being met. Commander Dayton Seiler, my predecessor in the Bureau job, was ordered in as officer in charge and I went along as his exec."

The station was ideally located, and before Truax arrived, there was already one rocket manufacturer on the premises, Reaction Motors, Inc.

RMI had produced the first commercial rocket engine in the United States. The small firm had its spiritual origin in New York City's Greenwich Village, where many a genius (and not a few crackpots) have been known to flourish. There, in 1937, a young man named James Wyld discovered that a pantry was an inferior place to operate a rocket. Seeking others of his kind, he teamed up with three fellow-members of the American Rocket Society (ARS) and eventually roosted in the backwoods New Jersey town of Wanaque. Upon testing a dandy little engine of Wyld's — it could fit in the palm of a hand and delivered 200 horsepower — the group incorporated and decided to sell it to the Navy.

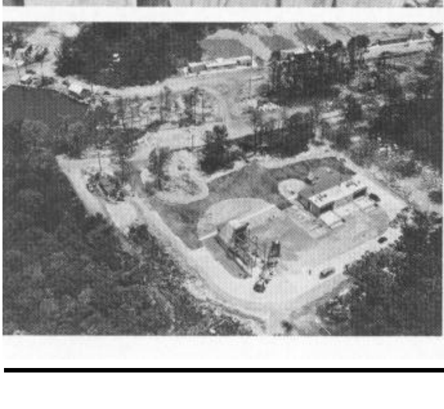
Lieutenant Fink Fischer was on the 1941 Bureau desk when the four-man company presented their invention. Fischer, of course, knew a good thing when he saw it, especially a rocket; a development contract was let. Now subsidized, the little company set up headquarters in Pompton Lakes (behind a storefront window which said "Pat's Tailor Shop") and immediately proceeded to disturb the peace.

Because operation of an item such as a 6,000-pound thrust rocket engine has a tendency to irritate an average man — it shakes the ground, cracks sidewalks, breaks dishes and induces flabby eardrums — a $50,000 lawsuit (exactly ten times the amount of their Navy backing) was initiated against RMI. Off they moved, and throughout the war they kept on moving, yet incredibly managing to manufacture liquid propellant airplane rocket engines (X-l, D-558), JATO units and engines for the *Gorgon* and *Lark*.

The Naval Ammunition Depot at Lake Denmark provided a haven where noise and hazard had been a way of life since the Revolutionary War. So, when it was eventually decided to inactivate it as a depot in the postwar period, BuAer selected the location as a site for its rocket activity. Reaction Motors had finally found a home.

What was the facility called? "Well," says Truax, "it started out as the Naval Aeronautical Rocket Laboratory, paralleling the Naval Turbine Laboratory, but then some people said, 'Oh, no! We're only going to do *testing* up there. (They knew that Truax always liked to get into *development* work.) It will be called the Naval Air Rocket Test Station.' So, that was the change in the name.

"Only trouble was, that came out NARTS — which is pretty close to NUTS. Not exactly the image we wanted."



JOC JAMES JOHNSTON

At left, Bob Truax, Fred Durant and Dayton Seiler were early members of the NARTS group at Lake Denmark. The facility offered many advantages for noisy activity. Durant, above, is now director of astronautics for the National Air and Space Museum.

VANGUARD

The Naval Air Rocket Test Station lasted ten years. During that period, its scientists were active in the screening of a number of monopropellants, fuels and oxydizers for auxiliary and prime power plants. Their work included evaluation of high energy fuels with an eye toward the feasibility of safe handling aboard ships at sea.

The in-service responsibility for the burgeoning liquid propellant rocket program had rested largely with NARTS until 1956, when BuAer began to divide its interest in such work between the Naval Air Missile Test Center (NAMTC) at Point Mugu, for flight test and evaluation, and NARTS, for static test and development. (BuOrd, meanwhile, had been given cognizance of all solid propellant work.)

In 1960, NARTS was disestablished and its facilities were turned over to the Army. The Lake Denmark work which had been started by LCdr. Truax in 1948 had been completed. And Truax himself had long since left the scene. During the early Fifties, he had taken opportunity to broaden his knowledge. To his B.S. in mechanical engineering, he added a B.S. in aeronautical engineering and, in 1953, topped them off with a master's degree in nuclear engineering. It was during these years that he also found time to make a number of ardent appeals for an American space flight and satellite program — the development of astronautics. Whether addressing his co-members of the ARS, speaking at the Congress of the International Astronautical Federation in Europe or writing articles, he hammered again and again with his theme: *We can have space flight in our time.*

Truax and his associates were by no means alone in their thinking. As has already been remarked, Soviet rocket technology was far more advanced than was generally believed by most Americans. The Russians actually had a history of remarkable progress in rocket development. In 1936, they were testing multistage rockets and in 1940 were starting mass production of the small military rocket called *Katyusha*, which was widely used throughout the war. Their first experimental rocket-powered fighter was designed in 1939 and was delivered for flight testing in October 1941. While their *practical* technology as applied to weapons of the V-2 nature was inferior, their *theoretic* status was on a par with Peenemuende's.

Contrary to popular belief, practically all the *leading* German rocket men ended up in the United States. What the Russians *did* get were hundreds of German workers and ordinary engineers, to add to their own already well developed core of rocket technology. As a result, by 1948, there were at least two Soviet projects drawn up for long-range rockets. One, the TT-1, was a three-stage liquid rocket designed for high altitude and *orbital* flight.

For the space dreamers of the world, 1948 was a year of ups and downs. Because of "political readjustments," the Soviet satellite project was sidetracked, for a while. Here in the United States, the Navy's HATV was cancelled. But studies continued. Rear Admiral Dan Gallery applied his persuasive powers to a revival of the idea of a joint Air Force/Navy earth satellite vehicle — to no avail. Secretary of Defense James Forrestal then issued an unfortunate statement to the Press referring to independent satellite studies by the three services. Angry reaction from home and abroad was immediate; here, because *secrecy* had been compromised, and from the Soviet Union, which denounced "madman Forrestal's earth satellite" as an "instrument of blackmail."

This then was the prevailing atmosphere in which Truax and his rocketeer associates tried to promote flight into space. Fortunately, their arguments found opportune support in 1954. For in that year, plans were being made for the Third International Polar year of the 1957-1958 period of expected sunspot activity. Meetings, in Europe, of the International Scientific Committee resulted in an expanded program for the International Geophysical Year (IGY) – one which would include the launching of small satellite vehicles for scientific purposes. Interest was aroused in both the U.S. and Russia.

On July 29, 1955, President Eisenhower announced that the United States would launch "small, unmanned, earth-circling satellites" as a part of the U.S. contribution to IGY.

Obviously, it was not an overnight decision. During the early NRL *Viking* experiments at White Sands, N.M., the concept of an "ideal rocket" for high-altitude research began to evolve with the accumulation of experience. And with the use of smaller, lightweight measurement payloads, the requirement for a smaller, less expensive rocket resulted in development of the highly reliable *Aerobee* series. An NRL study in 1954 indicated the feasibility of successfully placing a satellite in

orbit, using a vehicle based on the *Viking* as a first stage and the *Aerobee* as the second.

At about the same time, a Naval Aviator attached to the Office of Naval Research, Commander George Hoover, sought to enlist the aid of Wernher von Braun in a joint Army/Navy satellite program. Although Dr. von Braun's Army rocket people in Huntsville, Alabama, were more interested in the dream of putting up a huge space station, they could see a tiny satellite as a step in that direction. They agreed to support Cdr. Hoover in a project called *Orbiter,* based on the Army's *Redstone* booster and small, solid propellant *Loki* rockets.

When the Air Force tossed its hat into the ring with a proposal for an *Atlas/Aerobee-Hi* vehicle, it appeared the time had come for serious government evaluation — and a decision.

The Committee on Special Capabilities was set up within the Department of Defense, under the chairmanship of Dr. Homer Stewart. After some time the Stewart Committee chose the NRL proposal. Project *Vanguard* would have three missions: place in orbit at least one satellite during the 1957-1958 IGY, accomplish a *scientific* experiment in space, and *track* the flight to demonstrate that the satellite had actually attained orbit.

Vanguard actually started on September 9, 1955, when the Navy was authorized to proceed with the NRL proposal. A contract was awarded to the Martin Company for the building of enough launch components to comprise 16 vehicles. Two of these would be the older *Vikings* which would be used for crew training and testing of the third stage. NRL's Dr. John Hagen was named director, and a young engineer named Paul Walsh became his deputy. Milt Rosen who had put together the original proposal would be technical director, and a handful of other *Viking* men would make up the operational team.

One of the first problems was selection of a launch site. White Sands, where testing of the *Viking* and *Aerobee* had been done, was out of the question due to the danger, to populated areas, of falling pieces from the multistage launch vehicle. Of various other more appropriate sites, Cape Canaveral was chosen as being most economical. The Air Force was already building up the Florida complex and the Army's *Redstone* missile program was there. When Dr. Hagen suggested a sharing of facilities, the Army demurred on the basis that nothing could be allowed to interfere with the U.S. ballistic missile program. (The Army's *Jupiter-C* was also coming into being.) Dr. Hagen then managed to find enough money in the emergency fund of the Secretary of Defense to permit construction of *Vanguard's* own launch complex on the Cape. As a dividend, the block house and launch pad would be made available (after *Vanguard)* for future use in other programs.

To furnish the site, the entire *Viking* launch complex at White Sands, including tanks, plumbing, electrical hardware and gantry, was knocked down, shipped to Cape Canaveral and reassembled.

In purpose, the satellite program, under the direction of the National Commitee for IGY, was strictly a scientific venture, part of an overall plan to extend knowledge in the field of geophysics. It was a tri-service industry endeavor. Army teams, trained by NRL, operated most of the tracking stations where IGY scientists would extract data from the satellite itself as it circled the earth. The Air Force provided the launching site and the Navy was responsible for the design, construction, testing, and launch of the satellite itself,

By July 1957, the program encompassed the use of six preliminary rocket systems for test purposes, to be followed by six complete rocket guidance-and-control systems. Following the successful launch of an actual satellite, the next task would be to follow the little "moon" and to predict its future orbits by tracking.

The minitrack system of radio angle tracking was developed at NRL under the direction of Roger Easton. Easton recalls that, "The minitrack system was designed to enable scientists, for the first time, to follow the launching, direction of launch, and movement of multistage rockets; and to localize the time of arrival of the satellite over any given ground location within six minutes.

"Minitrack used established radio interferometric principles, A beam of radio energy is sent to receiving antennas on the ground as the transmitter-

Dr. John P. Hagen, head of the NRL Vanguard task force, had mountains of problems to overcome.

Dr. J. Paul Walsh was Hagen's deputy, is now superintendent of NRL's Ocean Technology Division.

The minitrack system of tracking was developed by Roger Easton, shown above with Vanguard satellite,

equipped satellite approaches and passes by overhead. By comparing the path length from the transmitter to one antenna with the path length from the transmitter to the next antenna, and so forth, it is possible to locate the satellite in its orbit, determining its angular position by radio phase-comparison methods. Similar measurements with another set of antennas, at right angles to the first set, help to fix the satellite accurately. Essentially, we had to create ten minitrack antenna stations across the world."

To this Dr. Hagen adds, "Captain Win Berg was the senior naval officer assigned to the team. He did an outstanding job in getting international cooperation. Minitrack stations were located and arranged for by groups from many countries eager to share in the operation. Many foreign nationals were brought to NRL where they took an intensive training course in the principles of radio tracking."

The status of *Vanguard* in September 1957 was roughly this: Test Vehicle Zero (TV-O) had been successfully launched, proving the capabilities of the pad complex and down-range facilities. The flight of TV-l, which at that time was the second stage, demonstrated successful trajectory, control and upper atmosphere ignition. Constant checkout difficulties in the hangar slowed progress on TV-2 but, towards the end of the month, it was being readied on the launch stand. However, on October 4, 1957, the Soviet Union announced it had put an earth satellite in orbit.

Suddenly, the *Vanguard* scientific program, which had been moving along at an unhurried pace while its scientists and engineers were ironing out the bugs inherent in the launching of *any* new rocket, found itself spotlighted as the losing contender in a space race with Russia. The NRL *Vanguard* operation, which consisted of only 15 staff people out of a 180-man team, began to feel the effects of national disappointment. That prophetic conclusion of the 1946 RAND report had become a reality.

As could be expected under the circumstances, there was a good bit of speculation as to reasons for the "failure," even though there had really been no such thing. The project, which had been a fairly open operation all along (largely ignored by the Press as an uninteresting American scientific experiment) became a "U.S. Navy folly."

The pressure was on; if *Vanguard* could not be our "vanguard in space," at least it would be second. A White House statement said so. On October 23, TV-2 was successfully launched. But TV-2 was only another systems check not the complete rocket, so no one cared. TV-3 was the one to watch — the one with the satellite — the one which would salvage some semblance of national pride. (A three-pound NRL satellite would be an emaciated answer to the 200-pound Russian *Sputnik,* but, at least it would be *something.)*

On November 3, TV-3 was on the pad; December 4 was the launch target date. The lengthy countdown procedure was started under an ever-increasing goldfish-bowl atmosphere. Press conferences in Washington and myriad newspaper accounts began to whip up a national "satellite fever." The members of the Press were not permitted, of course, on the actual site; no matter, they somehow kept tabs on every small detail of the activities at the *Vanguard* complex. On the scheduled day of launch, the beaches and balconies around Cocoa Beach sprouted a fantastic display of long-range photographic equipment. Roads in the vicinity of the Cape were clogged with cars, area motels bulged with reporters and correspondents from here and abroad. This was the day America would go into orbit.

Out on the pad, things began to go wrong. Loose plugs, leaks, sticking valves — and finally fatigue — beset the weary crew. The countdown had reached T (ignition time) minus 50 minutes shortly before 9:00 p.m., when weather forecasts indicated excessive winds for proper takeoff. The test was scrubbed.

On December 6, TV-3 finally rose off the launch stand — about two feet, before toppling over in a tremendous explosion that shook the blockhouse.

VANGUARD

As the flame and smoke cleared away, the *Vanguard* crew in the firing room could see, through the six-inch thick glass window, the forlorn little silver satellite lying where it had fallen in the smoldering debris, undamaged and beeping merrily away. It was an excruciating scene.

A few weeks before, perhaps with a sense of foreboding about *Vanguard,* the Secretary of Defense had ordered the Army to enter the satellite contest. So now, as the *Vanguard* crew cleaned up the mess of TV-3 and prepared the TV-3 B.U. (back-up) rocket, they could look over and watch Dr. von Braun's people busily setting up their *Jupiter-C.* Thus it was that on January 31, 1958, they had a ringside seat for the launch of the Western World's first satellite, *Explorer I.* NRL minitrack stations confirmed von Braun's achievement.

On February 4, the TV-3 B.U. made a beautiful takeoff. At 60 seconds into the flight, a wire separated in the guidance system and the 72-foot rocket tumbled through the sky, exploding in a fiery blob.

TV-4 was wheeled out. The work went on, still subjected to frustrating setbacks and impossible predicaments. As an example, on the night of March 7, when the countdown reached T minus 35 seconds, the switch was thrown that would cause the helium umbilical cord to disconnect and drop from the side of the rocket. But nothing happened. A hold was called and the crew stared, through bloodshot eyes, at the frost-coated umbilical-draped bird. It couldn't go anywhere with that attached. Well, they could send a man up on the arm of a "cherry picker," and he could yank the umbilical out! They had resorted to this procedure once before, and now it was standard practice to have the little motorized crane standing by.

It was standing by, all right, but the union man who drove and operated the machine was not. No one had *told* him to. And there was no other qualified operator.

It took two tantalizing hours to move the 100-foot gantry back to the simmering rocket where the engineers could loosen the stuck umbilical. About then high winds set in. Another scrub.

TV-4 was launched on March 17, 1958. Its performance was flawless; *Vanguard I* went into an orbit that will endure for more than 2,000 years. The next day, Dr. Wernher von Braun made a speech:

"Let me first express to you, and to whomever may be present from the Navy, my most heartfelt congratulations on the most wonderful success of our friends of the *Vanguard* project.

"Some of you, inspired by what you have read in the papers, may think that we have always had a very strong competitive feeling toward the *Vanguard* program. This is not exactly the case. We have always felt, at the Army Ballistic Missile Agency, that the *Vanguard* vehicle was an advanced design, compared to our own, and we were too much 'space men' in our hearts and too little interested in interservice problems not to wish the advanced *Vanguard* missile and its crew a full success in their endeavor.

"We were honestly and gravely concerned about the time schedule on which the *Vanguard* program was planned. After all, two years ago, when that program was initiated, the *Vanguard* constituted a brand new approach for the design of a satellite vehicle, whereas our own proposal essentially involved the utilization of existing sets of hardware for this particular accomplishment.

"Any such thing as successfully designing and developing a three-stage missile, with three brand new and unproven stages, on a time schedule of two years was absolutely unheard of, and when I say at this moment that I want to congratulate our friends of the *Vanguard* program on their fabulous success, I really mean it. What was done by the *Vanguard* group in these two years is absolutely unprecedented – the development of such a missile in such a short time is something that has never, never been done before."